NPAFC
Doc. 671
Rev. ____

Some Results of Studying the Kunashir Island Pink Salmon (Kuril Islands)

by

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Submitted to the

NORTH PACIFIC ANADROMOUS FISH COMMISSION

by the

Russia

March 2003

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:
Kaev, Alexander M., and L.V. Romasenko. 2003. Some results of studying the Kunashir Island pink salmon (Kuril Islands). (NPAFC Doc. 671). 16 p. Sakhalin Research Institute of Fisheries and Oceanography (SakhNIRO), Russia, Yuzhno-Sakhalinsk.

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ABSTRACT

Data describing a commercial catch of pink salmon from the Kunashir Island waters, abundance of adult fish and fry migrating downstream the Ilyushin River (test water body), and body length and weight and female fecundity are given. A conclusion that marine survival to a great extent determines the cyclic long-term fluctuations in abundance of the Kunashir Island pink salmon is drawn.

INTRODUCTION

Pink salmon is the most abundant species among Pacific salmon inhabiting waters of Kunashir Island. Despite the ancient history of its fishery, regular observations for the pink salmon reproduction have been started only in the 1990s. Data collected during these years both on abundance of juvenile downstream migrants and adult fish, and their biological indices let us to characterize some reproduction parameters of the Kunashir Island pink salmon. Both abundance and biological indices of adult fish and juvenile downstream migrants have been studied in the Ilyushin River. This is a typical island river (a main course is 9.3 km long), where common pink salmon spawning grounds make up 21 thousand m^2 (Kaev, Strukov, 1999). Numbers of adult fish in the river were counted two times (in mid-September and first half of October) at individual sites of spawning grounds. The obtained estimate of mean density of fish aggregations (ind./m^2) was multiplied by 4 (probable amendment for a duration of run and occurrence of aggregations outside the spawning grounds), then evaluated in a total spawning area, determining, in that way, a total number of pink salmon entered the river. Sex, stage of maturity, fork length, body weight, and fecundity were studied in fish sampled from research river catches by means of beach seines. Juvenile downstream migrants were counted by the method of sampling captures (Volovik, 1967). The collected data are given in the corresponding tables, where the following symbols are used: M is a mean value, S.D. is a standard deviation, CV is a

coefficient of variation, R is a coefficient of correlation, Lim is extreme values of a character considered, ? is a level of a confident probability, and N is a sample size.

RESULTS AND DISCUSSION

Pink salmon enter the rivers of Kunashir Island almost everywhere, excluding only the watercourses with the aggressive ambient medium (Zolotaya, Lesnaya rivers and others). In general, the island contains about 40 spawning rivers and brooks and 5 lakes, in tributaries of which this species spawns. A high density of fish aggregations on spawning grounds is observed almost in all of them, excluding some rivers flowing into Izmena Bay on the southern extremity of the island.

As a rule, the first pink salmon appear in rivers in late July – early August, main run occurs in September, the end of run in late October. In recent years, pink salmon from Ilyushin River have been counted at one and the same spawning areas for estimating a mean filling density on spawning grounds. As a result, like in rivers of the neighbor Iturup Island (Ivankov, 1967), fish from the early run were observed to occupy the upper spawning grounds, and those from the late run the lower spawning grounds. For the years of observation, a decrease in the portion of fish with the latter terms of spawning has been noted, especially evident since 1993 by the period of odd years, and since 2000 by the period of even years (Table 1). The same situation has been observed in other rivers, judging from the results of investigations of Okunevka, Prozrachny, Filatov, Severyanka rivers and some others. Moreover, the interannual changes in density of pink salmon aggregations on spawning grounds are synchronous in different rivers of Kunashir Island (Kaev, Strukov, 1999).

As far as Kuril rivers are very short and their spawning grounds occur already in several hundred meters from the mouth, the majority of fish enter the rivers having gonads at IV stage of maturity. Mass spawning is observed in the second – third 10-day period of September. Under the high abundance of fish with the latter terms of run, pink salmon spawning continues to late October. Nevertheless, in recent years under the partial reduction of this fish group, spawning grounds appear to be practically empty already by the mid-October.

During 1992-2002, the mean fish length constituted 50,4 cm under significant differences in estimates for different years. In comparison with females (47.2 – 52.9 cm),

the greater fluctuations occurred at males (47.0 – 54.6 cm), which are, as a rule, larger than females (Table 2). Body lengths of individual fish for the years of observation also ranged greatly (from 36 to 73 cm). The mean female fecundity was 1535 eggs, the lowest was observed in 1994 (1318 eggs), the highest fecundity was in 1993 (1867 eggs). Fecundity of individual females varied from 804 to 2921 eggs. In general, pink salmon were larger and more fecund in odd years than in even ones.

Changes in fish biological indices have been also observed during the spawning run. In some years, fish from the first half of run were much smaller. A significant increase in fish length in the second half of calendar terms of run was common, mainly, for the odd-year generations, in which a proportion of late-run fish was much lower, and fish from the even-year generations could be smaller in the second half of run than in the first half (Table 3). We should also note that, as a rule, in the middle of spawning run (first half of September) females (also males in some years) were smaller than from samples, taken before or after these time periods. One can see from the percentage ratio between sampled males and females, that in general a trend to the increase in female proportion during the spawning run, common for pink salmon, has been observed, although in individual cases it has been disturbed by the temporal increase in male proportion in the mid-run (Table 3).

Despite the late spawning, a peak of fry pink salmon downstream migration occurs in the second – third 10-day period of May, that is earlier in comparison with rivers located on the more northward Iturup Island, from which fry migrate the most intensively in the third 10-days of May – first 10-days of June (Kaev, Ardavichus, 1994). A completion of the downstream migration for the major fry pink salmon from Ilyushin River has been usually recorded in the first 10-days of June, although in small numbers fry pink salmon migrate downstream even in the first 10-days of July in individual years (Table 4). A number of pink migrants from different brood years varied from 1.8 to 21.5 mln in the Ilyushin River. Such a comparatively high number of fry migrants from a small water body, that is the Ilyushin River, reflects, in general, favorable conditions for species reproduction in rivers of Kunashir Island, that is proved by high estimates of the coefficient of downstream migration (a proportion of downstream migrants of the total fecundity of all females entered the river): mean 10.4 % under the range from 5.6 to 17.7 % in different years (Table 5).

The area of pink salmon spawning grounds in Ilyushin River comprises 7.9 % of the total area of their spawning grounds in rivers of Kunashir Island (266 thousand m^2). Based

on this ratio, total numbers of adult pink salmon and fry migrants in the island rivers are calculated. These estimates allow a comparison of the total return of adult pink salmon in individual years (commercial coastal captures and numbers of fish entered the rivers) with the harvest of juveniles from the corresponding brood years. The percentage of adult returns constituted, on average, 3.49 % under the range of 1.25 to 6.96 % (Table 6).

Table 6 illustrates also a synchronism of changes in annual commercial pink salmon catches and numbers of fish entered the island rivers ($R = 0.90$; $P < 0.001$; $N = 12$), that is the sizes of catches reflect a total pink salmon stock. On average, a portion of commercial catches constituted 59 % of the total returns. Judging from the statistics of commercial catches (Fig. 1), the increase in stock abundance could occur in the late 1940s (the post-war situation could not have no affect on the fishing intensity), and the same was in the early 1970s and in the second half of the 1990s. During the last and significantly greater increase in pink salmon stock, its catches became higher in the even years, whereas earlier the pink salmon from the odd-year generative line dominated by numbers more often.

Annual dynamics of fish commercial catches and river entries were in agreement too. In individual years, a great decline in fish numbers on spawning grounds in October comparing to September (Table 1) corresponded to the sharp decline in sizes of catches in the first half of September during the same years. As for the odd years, such a decline has been observed annually, beginning from 1993, and by the even years this occurred in 2000 and 2002. At the same time, terms of the beginning of fish approaches to Kunashir Island and rates of catches' increment in the first half of August remained without significant changes in these years.

Could these changes in dynamics of the pink salmon spawning run be reflected on dynamics of its juvenile downstream migration? No relationship was found between the calendar dates, when a half of the increasing value of adult commercial catches in the central part of the ocean coast of Kunashir Island occurred in one of the years, and the counted catches of downstream migrants in Ilyushin River in the next year, perhaps, due to different rate of development for embryos in warm and cold years. For instance, under the early terms of the 1995 fishery, there was a late downstream migration of juveniles, and under the late terms of the 1996 fishery, it occurred comparatively early (Table 7). Nevertheless, when correlating a seasonal dynamics of adult commercial catches with the

counted catches of juveniles and comparing them by the dates of the 50 % total catch, one can see that dynamics of the downstream migration for juveniles from the corresponding brood years has repeated the dynamics of approaches for fish from the parent broods during each year (Fig. 2). Identity of pairs of distribution patterns is proved by the criterion of Kolmogorov-Smirnov (Plokhinsky, 1970), which estimates (from 0.36 to 1.01, averaged 0.62) did not exceed the threshold values for the 95 % level of significance (? = 1.36).

Changes in dynamics of commercial catches and a ratio of river numbers of fish with early and late terms of their runs, as well as in biological indices could be caused by the existence of two large seasonal groups among pink salmon (Ivankov, 1967, 1971, 1984; Gritzenko, 1981; Efanov, 1989). This hypothesis is proved by the data on migration of pink salmon through the Pacific Kuril waters by two great, partly detached, “waves” (Kaev, Shershnev, 1998; Shubin, Kovalenko, 2000; Kaev, 2002), and what is more, similar differences in scale growth at the second year of life have been found between early and late migrants both in the ocean and in rivers of the eastern Sakhalin coast and Kunashir Island (Kaev, Romasenko, 2001). If this really occurs, our data on the compliance of dynamics of the adult commercial catches with that of the juvenile downstream migration (Fig. 2) prove the version (Ivankov, 1971; Koski, 1975; Gritzenko et al., 1987) about the possible affect of the fish-parents biological structure on the peculiarities of downstream migration of their juveniles. A quantitative assessment of the similar relationship has been given for pink salmon from the Auke Creek at Alaska: returns of adult fish from juveniles tagged in different dates of April and May, 1986 have been counted during August and early September, 1987; coefficient of correlation between the terms of downstream migration priority and posterior return was 0.865 (Taylor, 1988).

Data analysis on the ratio between pink salmon numbers at different stages of the life cycle of individual generations (Tables 5 and 6) shows that under the 6-fold fluctuations in numbers of fish entered the Ilyushin River in different years, the number of juvenile migrants has significantly depended on the number of parents ($R = 0.76$; $P < 0.01$; $N = 10$). Along with that, there was not observed a significant affect of density-dependant factors on the efficiency of reproduction in the freshwater cycle, because no relationship was found between the fish density on spawning grounds and estimates of the downstream migration coefficient ($R = 0.05$; $P > 0.05$; $N = 10$). A relationship between the numbers of juvenile downstream migrants and the corresponding returns of adult fish is weaker than between

the numbers of parents and downstream migrants. Its uncertainty (R = 0.65; P > 0.05; N = 10) is caused not only by a small number of the studied brood years, but also by the appearing tendency of decline in fish survival during the downstream migration of the great number of juveniles (Fig. 3). Under the short period of observations, this relationship is not statistically proved either (R = ?0.39; P > 0.05; N = 10). Nevertheless, estimates of return coefficient for all numerically significant generations are lower than its average long-term estimate. These data let us to conclude that marine survival, evidently, to a great extent determines the cyclic long-term fluctuations in abundance of the Kunashir Island pink salmon.

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Table 1. Density of pink salmon filling on spawning grounds in the Ilyushin River

Years	First survey		Second survey	
	Date	Ind./m^2	Date	Ind./m^2
1994	—	—	12/10	1.70
1996	14/09	2.31	08/10	1.64
1998	17/09	3.71	12/10	1.23
2000	13/09	4.87	10/10	0.55
2002	13/09	3.39	09/10	0.54
1995	—	—	10/10	0.96
1997	14/09	1.15	08/10	0.41
1999	10/09	0.98	04/10	0.15
2001	18/09	0.75	08/10	0.13

Table 2. Fork length (FL), body weight, and absolute fecundity (AF) of the Kunashir Island pink salmon in even and odd years

Years	Males			Females			
	FL, cm	Weight, g	N	FL, cm	Weight, g	AF, eggs	N*
1992	50.9	—	149	50.4	—	1769	151 (39)
1994	47.2	—	167	47.2	—	1331	101 (14)
1996	48.2	1313	117	47.8	1290	1433	133 (50)
1998	47.0	1278	180	47.3	1260	1318	115 (107)
2000	50.2	1623	204	49.8	1570	1541	196 (187)
2002	52.2	1776	148	50.7	1608	1568	152 (144)
Average	49.3	1498	—	48.9	1432	1493	—
1993	54.6	1903	159	52.9	1746	1867	141 (30)
1995	53.0	1776	162	50.2	1557	1391	124 (66)
1997	52.0	1729	146	51.2	1669	1597	128 (122)
1999	52.3	1777	163	49.8	1539	1531	137 (135)
2001	52.2	1744	58	50.4	1606	1565	58 (54)
Average	52.9	1786	—	50.9	1623	1585	—

*in brackets – number of females with a determined fecundity

Table 3. Body lengths of male and female Kunashir pink salmon in different time periods of entering the Ilyushin River

Year	Date	Males			Females		
		M	S.D.	N	M	S.D.	N
1997	12/08	49.8	5.09	30	51.4	2.30	20
	26/08	53.0	4.85	24	50.8	3.08	26
	29/08	53.3	3.52	30	50.6	3.34	19
	15/09	54.3	4.25	24	51.2	2.45	26
	30/09	52.8	3.47	12	53.0	3.39	13
1998	12/08	48.3	5.87	73	48.7	3.51	27
	15/09	46.2	4.44	50	46.8	2.77	50
	30/09	49.6	3.47	23	47.3	2.93	27
1999	11/08	50.0	3.27	29	47.5	2.64	21
	24/08	54.9	4.31	34	50.6	2.39	16
	30/08	53.1	4.28	22	49.4	1.95	28
	09/09	52.2	3.88	27	50.2	1.99	23
	17/09	54.6	4.99	19	51.8	2.75	31
2000	01/08	49.1	4.71	67	48.7	2.13	33
	15/08	49.8	3.66	32	50.1	2.56	18
	29/08	50.6	3.38	52	49.5	2.15	48
	11/09	51.4	4.33	20	49.4	1.99	30
	19/09	51.7	4.10	33	50.6	2.24	67
2001	18/08	51.1	4.18	52	49.6	2.94	34
	21/09	54.3	4.23	26	51.4	2.47	24
2002	01/08	51.1	5.31	53	50.3	2.90	47
	16/08	51.9	4.34	52	51.4	2.35	48
	11/09	53.8	4.17	43	50.4	2.75	57

Table 4. Dates of the beginning of downstream migration, mass migration (50 % and 90 %) and finishing of migration for pink salmon juveniles in Ilyushin River, Kunashir Island

Year	Terms of downstream migration			
	Start	50 %	90 %	Finish
1991	13/04	17/05	30/05	06/07
1992	16/04	24/05	07/06	04/07
1995	26/04	20/05	04/06	26/06
1996	28/04	23/05	02/06	22/06
1997	23/04	19/05	31/05	19/06
1998	21/04	14/05	24/05	10/06
1999	26/04	26/05	02/06	14/06
2000	28/04	13/05	24/05	17/06
2001	25/04	28/05	04/06	01/07
2002	26/04	10/05	20/05	08/06

Table 5. Abundance of pink salmon brood years in Ilyushin River, thousand ind.

Year of spawning	Entry to the river	Fry down-stream migration	DMC, %	Year of spawning	Entry to the river	Fry down-stream migration	DMC, %
1990	88	5337	7.6	1991	130	12695	13.0
1992	96	—	—	1993	78	—	—
1994	170	9752	8.6	1995	81	6657	11.8
1996	137	17426	17.7	1997	66	2950	5.6
1998	207	7882	6.0	1999	47	5327	15.4
2000	228	21453	12.2	2001	37	1756	6.5

Note: A coefficient of downstream migration (DMC) was determined from a ratio of number of fry migrants to the total female fecundity (nos. of females x average individual fecundity) of pink salmon in the Ilyushin River

Table 6. Correlation between the number of pink salmon migrants from the Kunashir Island rivers and total number of adult returns from corresponding brood years

Number of fry migrants		Adult returns, thousand ind.			RC, %
Year	Number, thousand ind.	From fishery	From entries to rivers	Total	
1990	55477	1376	1647	3023	5.45
1991	67598	1177	1216	2393	3.54
1992	160794	1022	988	2010	1.25
1993	—	4179	2153	6332	—
1994	—	2019	1026	3045	—
1995	123518	3164	1743	4907	3.97
1996	84317	1007	830	1837	2.18
1997	220729	4051	2622	6673	3.02
1998	37367	859	596	1455	3.89
1999	99837	4059	2888	6947	6.96
2000	67480	1152	469	1621	2.40
2001	271735	3409	2613	6022	2.22

Note: Return coefficient (RC) was calculated as the ratio of total returning adult pink salmon to the Kunashir Island to the calculated number of fry migrants from all the island rivers

Table 7. Dates of the 50% increasing catches of adult pink salmon (a central part of the ocean coast of Kunashir Island, trap nets) and fry migrants from the corresponding brood years (Ilyushin River, fingerling seine)

Odd-year broods		Even-year broods	
Adult fish	Juvenile fish	Adult fish	Juvenile fish
1991/09/04	1992/05/24	1994/08/29	1995/05/20
1995/08/16	1996/05/24	1996/08/28	1997/05/19
1997/08/16	1998/05/14	1998/08/20	1999/05/26
1999/08/15	2000/05/13	2000/08/22	2001/05/28

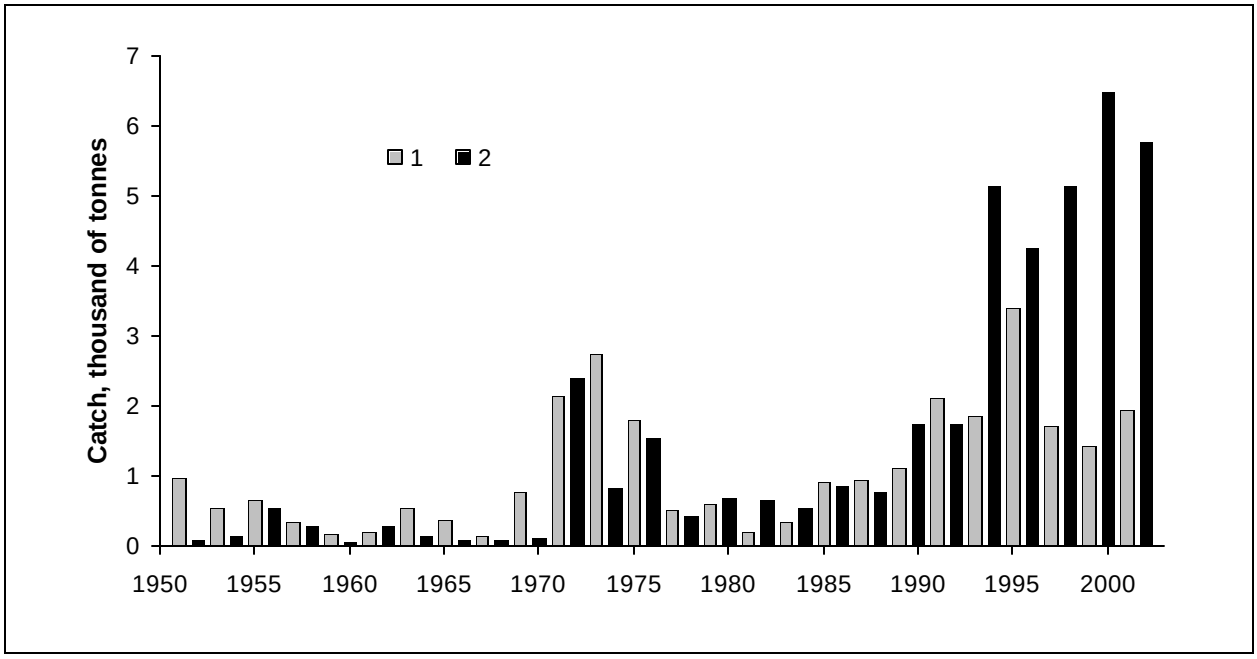

Fig. 1. Dynamics of pink salmon commercial catches in odd (1) and even (2) years in Kunashir Island waters

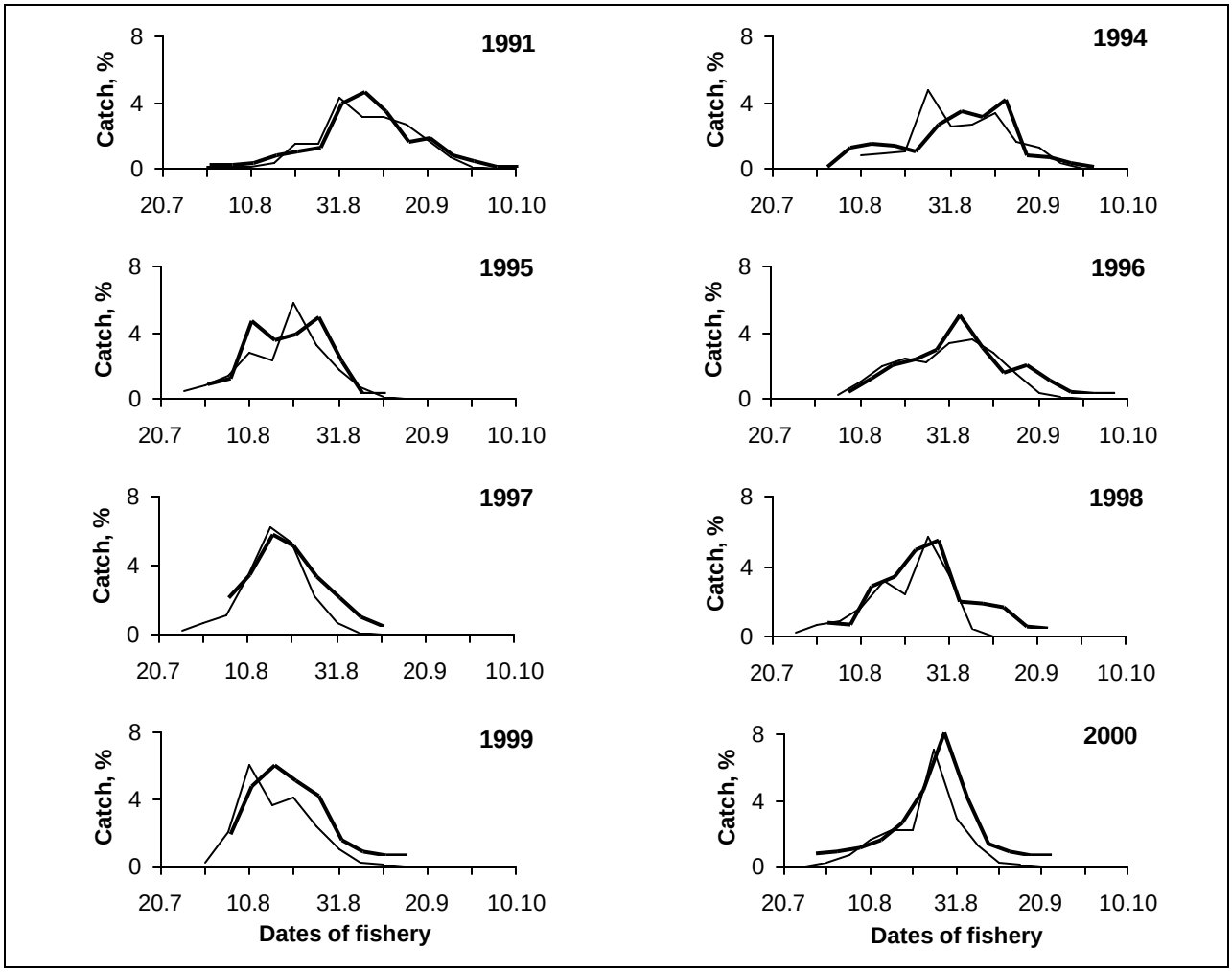

Fig. 2. Dynamics of juvenile pink salmon downstream migration in Ilyushin River, Kunashir Island (thin line) in relation with dynamics of coastal commercial catches of fish from parent stocks in 1991, 1994-2000 (thick line)

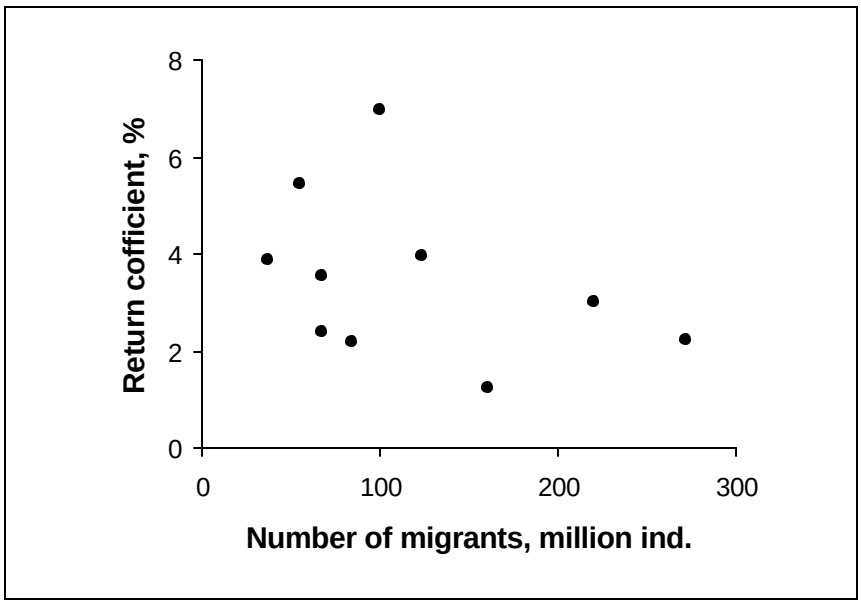

Fig. 3. Changes in estimates of the Kunashir Island pink salmon return coefficient due to the number of migrants from rivers